

Use of the preparation based on *Solanum nigrum* as a potato yield stimulator

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Abstract

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The use of herbal preparations is an environmentally friendly and biosafety alternative to the use of chemical stimulants to increase the productivity of agricultural plants. The article presents the results of studies of the effect of foliar treatment with the preparation of black nightshade infusion (*Solanum nigrum*) in concentrations of 0.5% and 0.25% (dry matter) on the productive qualities of potatoes of the Latona variety. The obtained data indicate that the treatment of potatoes with a preparation based on Black nightshade at a concentration of 0.5% increases the average potato yield by 41.5%. At the same time, the number of tubers of the food fraction (size > 55 mm) increases by 47.6%, of the seed fraction (size 35-55 mm) by 35.3%. The use of this treatment is efficient both when growing food and seed potatoes.

Keywords: potato; black nightshade; biomass; tubers, yield

Introduction

To increase the efficiency of agricultural production, stimulants and means of integrated plant protection are now actively used, which contribute to obtaining high yields of high quality (Ghani, 2013). Plant growth regulators are becoming more and more popular among farmers, since these drugs significantly increase the quality of grown products, as well as increase yield characteristics, regulate the timing of flowering and ripening (Puchkov & Abdelkader, 2017; Abbott et al., 2018; Mitrofanov & Novikov, 2020). They have the ability to influence the immune potential of plants, physiological and biochemical processes in plants, resistance to phytopathogens, and as a result, the yield and quality of tubers. Puchkov & Abdelkader (2017) in his studies showed that the significant immunostimulating effect of biologically active compounds that make up some growth regulators, when used in combination with fungicides, can reduce the rate of fungicide consumption by 25-30%. According to this researcher, their introduction into produc-

tion will contribute to obtaining environmentally friendly and cheaper (since prices for fungicides are constantly growing) products. The most widespread in modern plant growing practice are synthetic growth regulators, it has been established that with their help it is possible to control vital processes and achieve the realization of the possibilities inherent in the plant organism, but not manifested in specific conditions.

However, along with numerous advantages, these drugs also have a number of negative features: firstly, the synthetic route for obtaining growth regulators is very expensive and this leads to their high cost; secondly, many synthetic plant growth regulators are environmentally unsafe. The facts of the negative effect of many chemical preparations, including growth regulators, on the chromosomal and genetic apparatus of plants, and, consequently, on their economic properties, have been established. In many cases, these effects are irreversible (Devi et al., 2009). Also, according to Yadav et al. (2020) chemical-based drugs pose a serious threat to both human health and the environment. There-

fore, the question of finding and producing cheap, highly effective, environmentally friendly plant growth regulators from plant raw materials of current interest (Krebs et al., 2006; Gorbyleva & Borovskii, 2018).

It is known from many sources that the use of herbal preparations for treating seeds and vegetative plants has a positive effect on the productivity of agricultural, fruit and berry, vegetable, industrial and ornamental crops (Jasim et al., 2007; Singh et al., 2013; Dahshan et al., 2018). The resistance of plants to unfavorable environmental factors increases: drought, frost, and the susceptibility of plants to diseases and pests (Humauan & Alam, 2007; Wang et al., 2007; Khan, 2009). The use of plant extracts has shown a positive result on the yield and quality characteristics of potatoes.

A positive response of potato growth and yield to the foliar application of the extracts from *Ascophyllum nodosum* (Primo, and *Ecklonia maxima* (Kelpak SL) was shown in studies Wierzbowska et al. (2015) and in studies Cwalina-Ambroziak et al. (2015) were proved the effectiveness of treatment with biological products based on algae not only on potato yield, but also on disease resistance. Majeed et al. (2011) study was investigated the effect of water extracts of leaves of medicinal plants (*Podophyllum hexandrum*, *Withania somnifera* and *Xanthium strumarium*) on the yield and spread of late blight caused by *Phytophthora infestans* in potato plantings. Foliar sprays of 25% (w/v) with extracts of these medicinal plants significantly reduced the development of late blight and contributed to an increase in the yield of potato tubers to 14.93 t/ha. Yasser & Hassan (2018) studied the impact of gibberellic acid (GA 3), indole-3-butyric acid (IBA), garlic extract, yeast extract and green tea extract with various concentrations on the yield of variety Burren potatoes, and obtained data of the positive effect of these treatments on the productivity of potatoes and the advantages of foliar treatment with these preparations over pre-planting treatment of tubers. The positive effect of herbal preparations is associated with the valuable biologically active composition of plants.

Many researchers have proven that the leading role in the regulation of physiological and biochemical processes of plant growth and development belongs to triterpene glycosides, infusions of plants containing these substances are very often used as stimulants (Stekhova, 2005; Giobanu et al., 2005; Jiang, 2006; Dinda, 2010; Sergiev et al., 2004; Giobanu et al., 2005). According to our research, the list of such plants can be expanded by widespread and available plant species that are not yet used in crop production, but which contain biologically active substances, especially triterpene glycosides, such as black nightshade. Black night-

shade (*Solanum nigrum*) is found throughout Europe and Asia, as well as in North America. Due to its rich composition of biologically active substances, Black nightshade is widely used in medicine (Ngbolua, 2016). The high biological potential of Black nightshade (*Solanum nigrum*) is due to its unique chemical composition. *Solanum nigrum* contains many steroidal glycosides, steroidal alkaloids, steroidal oligoglycosides, including solamargine, solasonine, solavilline, solasdamine, and solanine, flavonoids, steroidal saponins and glycoprotein, many polyphenolic compounds such as gallic acid, protocatechuinate and naringenin, which possess strong antioxidant and anticancer activity (Hoang & Yen, 2014).

On the assumption of the chemical composition of this plant, there is reason to believe that it can have a stimulating effect on the growth and development, and hence the productivity of agricultural crops (Anikina, 2021).

Purpose of the research: To investigate the effect of black nightshade biomass infusion on potato productivity and fractional composition of the crop.

Material and Methods

For the research, field experiments were laid in the north-east of Kazakhstan at the field site of the Timur farm in 2018-2020. Temperature conditions were within the range of long-term average data (Figure 1).

Climatic conditions in the north-east of Kazakhstan are characterized by temperature contrast. The run-up of temperature fluctuations in summer can be 25°C per month. The predecessor is alfalfa. The soils are chestnut, silt,

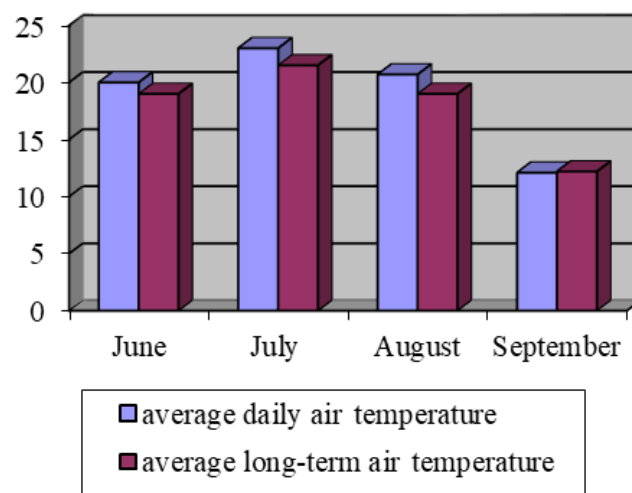


Fig. 1. Average air temperature data for the growing season 2018-2020

low-humus. Clays and loams serve as soil-forming rocks. In the experiment, agricultural technology was used in accordance with the intensive technology of growing potatoes.

Planting was carried out with a planter made by CRA-MER GmbH (Germany). Landing pattern 75 × 25. The tubers were preplant treated with TMTD VSK preparation at a dosage of 5 l/t. When growing, a pre-emergence treatment with a Tornado preparation at a dosage of 7 l/ha was used. To maintain soil moisture in the active layer at a level not lower than 70% HB during the growing season, 5-8 irrigations were carried out, depending on the humidity conditions of the year, the irrigation rate was 2000-2500 m³/ha. Watering was done with the Valley Rainger. The harvesting of the test plots was carried out manually in the first ten days of September. The studies were carried out on potatoes of the Latona variety according to the method of field experiment. Three variants of the experiment were made.

Variant 1 – with treatment with a 100% solution of the preparation

Variant 2 – treatment with a 50% solution of the preparation

Option 3 – water treatment (control). 3 – water treatment (control).

A 100% solution of black nightshade infusion (*Solanum nigrum*) corresponds to a concentration of 0.5% (on dry matter), 50%, respectively, 0.25%. The preparation was prepared as follows:

- Collecting plant materials, cleaning and shredding them.
- Placing the plant mass in a container for infusion (glass jar). The plant mass (stems and leaves) was chopped with a knife and poured with hot water heated to 90°C in a mass ratio of 1:10.
- Keeping the plant mass and extract for 1 hour at a temperature regime that contributes to a faster and more complete process of the release of active substances from the plant mass.

Then the resulting infusion was poured into a garden sprayer, which was used for treatment. In option 1 – with

100% preparation, the infusion was used without dilution. In option 2 – with 50% of the preparation, an infusion was used, half diluted with water.

Potato bushes were treated with the prepared solutions in the budding phase at the rate of approximately 10 ml per plant. Experimental bushes were dug out 45 days later. Counting the productivity of potatoes was carried out on 30 bushes in each variant. According to the standard, food potatoes were considered tubers over 50 g (size ≥ 55 mm), seed ones 30-50 g (size of 35-55 mm), non-standard tubers less than 30 g (size ≤ 35 mm).

The excavated tubers were divided into 3 fractions (food, seed, non-standard) and each fraction was weighed on an electronic scale. The results were submitted to statistical processing using an analysis of variance (STATISTICA 10 software package) and differences between means were compared by the Duncan's test at p = 0.05.

Results and Discussion

The data were obtained during the research, and the average values of the data are presented in Table 1. When analyzing the number of tubers, it was revealed that when using foliar treatment of 100% of the preparation, the number of tubers of the food fraction increased by 47.6%, when using 50% of the preparation by 20.9%. At the same time, when treated with 100% of the preparation, the number of seed fraction tubers increased by 35.3%, when using 50% of the preparation, by 23.5%. Treatment with the prepara-

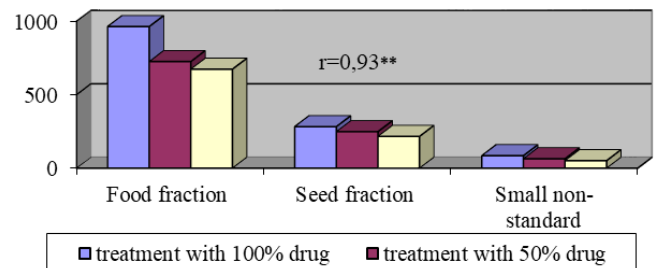


Fig. 2. Increase in the mass of potato tubers, depending on the stimulating treatment

Table 1. The number of potato tubers by fractions, depending on the treatment

Variant	Average amount of tubers of 1 bush by fractions, pcs			Total number of tubers on average, pcs
	Food (size > 55 mm)	Seed (size 35-55 mm)	Small not standard (size < 35 mm)	
Preparation treatment 100%	7.75	5.75	5.75	19.25
Preparation treatment 50%	6.35	5.25	5.55	17.15
Water treatment	5.25	4.25	5.75	15.25
LSD _{0.05}	0.12	0.17	0.08	0.15

tion did not have a significant effect on the number of tubers of the small non-standard fraction.

As a result of the experiment, data were obtained indicating a significant stimulating effect of the preparation based on Black nightshade on the productivity of potatoes (Figure 2). The increase in the total mass of tubers of one bush when treated with 100% with the preparation averaged 41.5%, when treated with 50% with the preparation it averaged 10.3%. The increase in the mass of the food fraction of the tubers was 43.1% on average when treated with 100% with the preparation, and when treated with 50% with the preparation, the average increase was 7.7%.

The obtained data are combined with the data of other researchers regarding the fact that plants containing triterpene glycosides can be potential stimulators of productivity, since these substances play an important role in the regulation of physiological and biochemical processes of plant growth and development (Sergiev et al., 2004; Giobanu et al., 2005; Dinda et al., 2010).

Conclusions

In the course of the research, it was revealed that the use of foliar treatment of potatoes in the budding phase with a preparation based on Black nightshade increases the average yield of potatoes to 41.5%. At the same time, the number of tubers of the food fraction increases by 47.6%, of the seed fraction by 35.3%. Thus, foliar treatment with black nightshade infusion stimulates the yielding qualities of potatoes, as well as increases the yield of tuberous units, that is, the multiplication factor, which is of great importance in the primary seed production of potatoes. The use of such treatment is advisable both for growing food and seed potatoes.

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